Setting Up TMG Radiation

Overview of Radiation

Radiation modeling in TMG is divided into two main areas: radiative heat exchange through reflection, emission and absorbtion within the model, and radiative heat sources specified as boundary conditions. Radiative heat exchange is controled by Radiation Request entities. Radiative heat sources are specified as either Orbit Modeling, Diurnal Heating, or Radiative Heating entities.

A Radiation Request instructs TMG to calculate view factors, perform shadowing checks and calculate diffuse and specular reflected radiative exchanges among selected elements. The radiative energy originates not from the Radiation Request, but from one of two sources: the temperature of the elements, or a radiative heat source boundary condition. The radiation originating from the temperature of the elements is infrared, while radiative heat source entities emit solar spectrum energy (with one exception). Whatever its origin, the energy is reflected, transmitted or absorbed among the elements in the Radiation Request depending on their optical properties and their geometric relationship. Ray-tracing and shadowing can be controlled. The resultant radiative field is incorporated in the solution matrix.

Only elements defined with emissivity between 0 and 1 can participate in a Radiation Request. The following elements types are supported for radiation:

- thin shell
- beam
- axisymmetric shell

In addition you can make the following selections when defining a Radiation Request:

- free faces of 3-D solid elements
- free edges of axisymmetric solid elements

Use the filter to make it easier to select these items. Make sure the solid elements have emissivity defined.

All radiative exchange is calculated from one element to another element within an enclosure. A radiation model can have one or more enclosures. If the geometry of the object itelf does not define an all-inclusive enclosure, a *Space Enclosure* entity must be created to absorb the energy lost from the system. In effect, a *Space Enclosure* creates one extremely large cube made of six elements (or more if so specified) that encloses the model and the space around it. The software creates these elements during the solve and deletes them afterward.

Within the radiation enclosure, the calculation of energy transferred through radiation is based on view factors between each pair of elements. The black body view factor (also called the form factor) evaluates the fraction of the total diffuse radiative energy emitted by a surface that is transferred to another one. The black body view factor depends only on the geometry of the elements and their orientation to each other.

All elements that have an unobstructed view of each other will have their view factors computed first. Then, a shadowing check will be performed on the remaining elements using element subdivision to evaluate what portion of the element's surface projection on another element's surface is occluded by an obstacle.

Radiative conductances are calculated with the Oppenheim's method unless you specified Gebhardt's method.

Ray-tracing will automatically be performed if any solar specular or solar transmissive surface is defined in the model. Rays are launched from the specular or transmissive surfaces that have a view to the sun. These rays are then trace through the enclosure. TMG takes advantage of the view factors to optimize the ray tracing process. An optional ray-tracing calculation exists for the infrared spectrum and diffuse solar reflection.

Radiation calculation can be very expensive in terms of time and memory requirements. Many functions and parameters exist to help you reduce the calculation required.

Enclosures

Enclosures are the building blocks of a radiation model. Within an enclosure you can control what needs to be calculated. If a set of elements forms an actual physical enclosure, defining it as such will reduce computing time by allowing you to specify parameters that are appropriate to those surfaces and limiting view factor and shadowing calculations to those that are possible.

For example, if all elements within an enclosure have an unobstructed view of each other, shadowing checks do not need to be calculated. For another example, orbital calculations can be omitted for the elements on the interior of a spacecraft since they do not have a view to space.

In another scenario, local parameters can be specified to calculate shadowing more accurately within certain enclosures, while a global parameter is used for the rest of the elements. A view factor threshold can be set to prevent the costly calculation of view factors for small or distant element pairs, or pairs with highly oblique views.

Options are also available to limit view factor calculations to specific groups.

View Factor Residuals

Within an enclosure, the black body view factor sum for an element should add up to one. Because of imprecision in the calculation (due to shadowing for example) this is rarely the case. The residual view factor is this difference from unity and it must be accounted for in the radiation calculation.

The residuals are usually added to existing view factors. Several options are available with general guidelines to determine the best approach to deal with the residuals, depending on the physical model.

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